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WOOD-BORING MOLLUSKS FROM THE HAWAIIAN, SAMOAN, AND PHILIPPINE ISLANDS

WOOD-BORING CRUSTACEA FROM HAWAII AND SAMOA

BY

ROBERT CUNNINGHAM MILLER

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WOOD-BORING MOLLUSKS FROM THE HAWAIIAN, SAMOAN, AND PHILIPPINE ISLANDS

BY

ROBERT CUNNINGHAM MILLER

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In the autumn of 1922, under the auspices of the Committee on Marine Piling Investigations of the National Research Council, test boards for marine borers were placed at several localities in the Hawaiian Islands, and at Tutuila, Samoa. In April, 1923, a similar board was placed at Cavite, Manila Bay, Philippine Islands. These test boards, which were of a standard design (Clapp, 1923), were installed and maintained through the coöperation of the Bureau of Yards and Docks of the United States Navy, and the United States Lighthouse Service. At intervals of two weeks a block was removed from each board and forwarded to the Zoological Laboratory of the University of California. In this laboratory the blocks have been examined by the writer, with the assistance of Mr. Harold Kirby, the work being carried on under the direction of Dr. C. A. Kofoid as a phase of the investigations of the San Francisco Bay Marine Piling Committee.

Extremely little is known regarding the marine borers of these islands. The results here reported are not looked upon as affording at all a complete list of the species occurring in these regions, but they do give an idea of the distribution and relative abundance of the commoner and hence more destructive forms.

The molluscan borers have been represented in the test blocks by one species of *Martesia* and seven species of *Teredo*, of which four appear to be distinct from any as yet described. The genus *Bankia* has not been represented in any of the material that has come to hand.

The stations from which blocks have been received are: Pearl Harbor (two stations, United States Navy Coaling Plant and Kuahua Island); Honolulu Harbor; Nawiliwili Bay, Island of Kauai; Tutuila, Samoa (United States Naval Station); and Cavite, Philippine Islands.

Genus **Martesia**

Martesia striata Linn.

Plate 8, figures 1–5

This species has occurred occasionally in the blocks from Pearl Harbor, rarely more than three or four small specimens of a maximum length of 2 cm. occurring in any one block. That it is of economic importance in this locality has been shown in an earlier paper (Kofoid and Miller, 1923), where instances were cited and figured of damage to piling and of penetration through redwood sheathing and an inside layer of tarred ship's felt.

Burrows attributed to this species were also found in one of the blocks from Nawiliwili, although the animals themselves had been lost out before the block was sent in, thus precluding certain identification.

At Cavite, attack by this species on the test blocks has been rapid and extremely destructive, the damage by *Teredo* at this locality, although considerable, being secondary to that occasioned by *Martesia*. Blocks exposed four months or longer were usually in a crumbling condition, the surface being riddled by small *Martesia*, mostly less than 2 cm. in length. The deeper portions of the block were at the same time penetrated by the longer burrows of *Teredo*.

Genus **Teredo**

Teredo parksi Bartsch

Plate 9, figures 6–15

This species was described by Bartsch (1921) from piling in Pearl Harbor. The shell is characterized by a broad anterior lobe and a consistently small auricle, characters which appear to exhibit less variability in this species than in most others. The pallets are readily distinguished by the long stalk and short, deeply excavated blade which is covered the greater part of its length by a dark epidermis. The blade is usually more deeply excavated on the outer than on the inner face, a character which is most accentuated in the Samoan specimens. The latter tend also to have more regularly shaped, straight-sided pallets. These characters, however, appear too variable to be of systematic importance. It is possible that further study may indicate a separate category for the Samoan specimens, but the material now at hand does not warrant such a step.

Teredo parksi appears to be the dominant species in the islands, being present in the test blocks from all localities except Nawiliwili. The heaviest attack by this species occurred in Pearl Harbor. Blocks submerged here September 1 showed considerable surface attack at the end of a month, and by the end of the second month a length of 8 cm. had been attained by the largest specimens. At the end of five months the blocks were thoroughly honeycombed and beginning to crumble as a result of the combined attack of *Teredo* and *Limnoria.* The rate of growth under normal conditions at this locality appears to be from 3 to 5 cm. a month during the first five months, at the end of which time the blocks were usually so crowded as to hinder or stop further growth. A burrow 18.5 cm. in length occurred in a block submerged five months at the United States Navy Coaling Plant, and a burrow 22.5 cm. long was found in a block submerged six months at Kuahua Island, these being the maximum lengths recorded.

This species is incubatory, and in Samoan waters becomes sexually mature within a few weeks after entering the wood. Specimens containing well developed larvae in the gills were found in blocks submerged only two months at Tutuila. Potts (1923) reports that rafts in the water only twenty-four days in Pago Pago Harbor contained shipworms which were producing free-swimming larvae; it is probable, although not certain, that he was dealing with this species. In Pearl Harbor *Teredo parksi* appears to mature more slowly and to reach a larger size, the difference doubtless being due to temperature conditions.

In Samoa *Teredo parksi* appears to breed uninterruptedly throughout the year, but in Hawaii the breeding activity, as indicated by settlement of larvae, reaches a maximum in August, September, and October, progressively decreases from November to March, and reaches a minimum, possibly ceasing altogether, in April.

Teredo bartschi Clapp

This species was described by Clapp (1923) from Port Tampa, Florida. Specimens of a *Teredo* prevalent in the later blocks from Nawiliwili compare closely with paratypes of this species which I have received from Mr. Clapp. This species occurs numerously in the blocks placed after September, and sporadically in the earlier blocks.

Teredo diegensis Bartsch

This species, described by Bartsch (1916) from San Diego, occurs sporadically in the blocks from Pearl Harbor, Honolulu Harbor, and Nawiliwili. The specimens from the Islands differ from typical *T. diegensis* in having the ridges on the shell more close-set and the epidermis of the distal portion of the blade of the pallets more transparent, so that the outline of the oval calcareous portion within can be plainly seen. In preserved specimens that we have received from Nawiliwili the distal epidermis is of amber clearness; but the dried pallets have the epidermis darker and more opaque, so that they are not distinguishable from those of specimens from the California coast.

Teredo affinis Deshayes

Plate 11, figures 26–30

Shell similar to that of *Teredo furcillatus,* but with the anterior lobe in general narrower and the auricle broader, differences which have been fairly constant in all the specimens examined.

Pallets with a long, slender stalk; blade consisting of a short, urn-shaped, calcareous base, surmounted by a dark brown, chitinous distal portion, wholly uncalcified, and of very irregular shape. In specimens considered typical the distal portion consists of a narrow, elongate, cupped median extension, very deeply excavated on the outer, less deeply on the inner face; and further cut away on each side nearly to its juncture with the calcareous base, where the chitinous portion is spread out abruptly and slightly excavated to form two shallow lateral cups. As a result of wear the median extension may be excavated nearly to the base within as well as without, so that the pallet appears to end in two slender leathery fingers. The lateral excavations are usually unequal, and one or both may be entirely lacking. The calcareous base is cut off abruptly at its juncture with the distal chitinous portion.

This species was described by Deshayes (1863) from Reunion Isle.

Notwithstanding the irregularity in the form of the pallets, the characteristic leathery distal projections enable them to be recognized almost at a glance. But the chitinous portion rather readily comes free of the calcareous base, which then has a deceptive appearance of completeness, and might be mistaken for a pallet of some other species.

The test board at Nawiliwili was placed February 1, 1923. In the earlier blocks *Teredo affinis* predominates, and is very destructive; but in the blocks placed after September it is almost entirely replaced by *Teredo bartschi* and *Teredo diegensis.* A few specimens of *T. affinis* have been found in the blocks from Honolulu Harbor.

Teredo furcillatus sp. nov.

Plate 10, figures 16–20

Shell with the anterior lobe shorter and narrower than in *Teredo parksi,* and the auricle decidedly longer and broader. The shell is less highly polished and transparent, and the ridges of the anterior median area are more coarsely denticulated than in *T. parksi.*

Pallets with the stem long and the blade small, variable in shape, the distal portion deeply excavated on the outer and usually also on the inner face, although the latter in some cases is only slightly notched. The most distinctive feature of the pallets is the absence of a dark periostracum, the distal portion of the blade being either light yellowish or perfectly white. The name is suggested by the resemblance of the pallets to a small two-tined fork (Latin *furcilla*).

The measurements of the type are: *shell,* height, 3.3 mm.; length, 3.4 mm.; *pallets,* length of blade, 1.7 mm.; width of blade, 1 mm.; length of stalk, 2 mm. The type, from Tutuila, Samoa, has been placed in the Museum of the California Academy of Sciences, San Francisco, as no. 1729. Paratypes have been placed in the collections of the Department of Zoology, University of California, the Academy of Natural Sciences, Philadelphia, and the United States National Museum.

Teredo furcillatus has occurred in limited numbers in the blocks from Tutuila and Honolulu Harbor. The longest burrow recorded was 6.7 cm. The species does not appear to be of much economic importance.

Teredo samoaensis sp. nov.

Plate 10, figures 21–25

Shell similar to that of *Teredo furcillatus,* but generally more transparent, and with a smaller auricle. Interiorly the shell is characterized by a very broad, irregular apophysis, which is a useful, although not infallible guide in the identification of the shell.

Pallets with a stalk of medium length and a long tapering blade which is divided into two distinct portions. The basal portion, comprising about one-half the length of the blade, is broadly ovate and calcareous; the distal portion consists of a narrower, nearly straight-sided, more or less completely calcified semicylinder, flattened on the inner face, slightly cupped at the extremity. At the juncture of these two elements the pallet is encircled by a band of brown epidermis, which sometimes more or less completely envelops the distal portion.

The type specimen, from Tutuila, Samoa, is no. 1730, Museum of the California Academy of Sciences, San Francisco. Paratypes have been placed in the collections of the Department of Zoology, University of California, the Academy of Natural Sciences, Phila-

delphia, and the United States National Museum. The measurements of the type are: *shell,* height, 3.8 mm.; length, 3.8 mm.; *pallets,* length of blade, 2.9 mm.; width of blade, 1.3 mm.; length of stalk, 2.1 mm.

This species has been found only in Samoa, where it occurred commonly in the blocks from a board placed in November, 1923. This board was lost before adequate data were secured, and a second board placed the following June was not attacked at all by this species.

Teredo trulliformis sp. nov.

Plate 11, figures 31–34

Shell with a greatly reduced auricle, which is so fused with the posterior median portion that the boundary between the two can scarcely be detected on the exterior surface. Interiorly the auricle overlaps the posterior median portion a little distance, and its anterior edge can be distinguished, but does not form a shelf with a cavity behind it as it does in all of the foregoing species.

Pallets with a short, broad blade, and a stalk of medium length which, instead of tapering toward the end, becomes gradually expanded, like the handle of a trowel (Latin *trulla*). The distal portion of the blade is covered by a grayish or brownish epidermis, and the extremity is characterized by a shallow crescent-shaped excavation.

The posterior end of the tube is divided by a calcareous partition, forming two siphonal openings.

The measurements of the type are: *shell,* height, 3.4 mm.; length, 3.2 mm.; *pallets,* length of blade, 1.8 mm.; width of blade, 1.2 mm.; length of stalk, 1.3 mm. The type, from Honolulu Harbor, is no. 1731, Museum of the California Academy of Sciences, San Francisco. Paratypes are in the collection of the Department of Zoology, University of California, the Academy of Natural Sciences, Philadelphia, and the United States National Museum.

This species occurs commonly in the blocks from Honolulu Harbor, and somewhat rarely in the blocks from Pearl Harbor and Nawiliwili. The longest burrow recorded measured 9 cm.

Zoological Laboratory,
University of California.

Transmitted March 20, 1924.

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ERRATUM

Page 145, line 7 from bottom. *For* four *read* three.

EXPLANATION OF PLATES

PLATE 8

Fig. 1. *Martesia striata* from Pearl Harbor, dorsal view. × 2.

Fig. 2. Same, lateral view.

Fig. 3. Same, ventral view.

Fig. 4. Split section of a test block submerged five months at Cavite, showing *Martesia striata* in place in burrows. The burrows exhibiting a calcareous lining are those of *Teredo*. × 9/10.

Fig. 5. Portion of the surface of a block submerged nine months at Cavite, showing destruction by *Martesia striata*. × 9/10.

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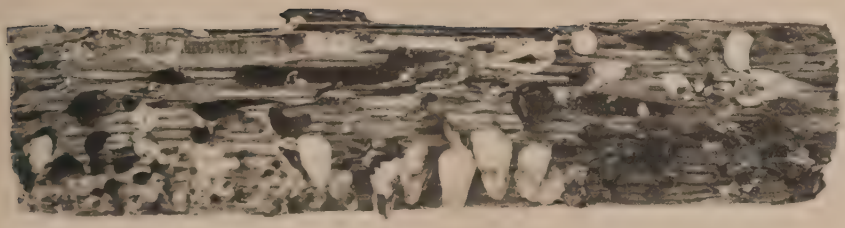

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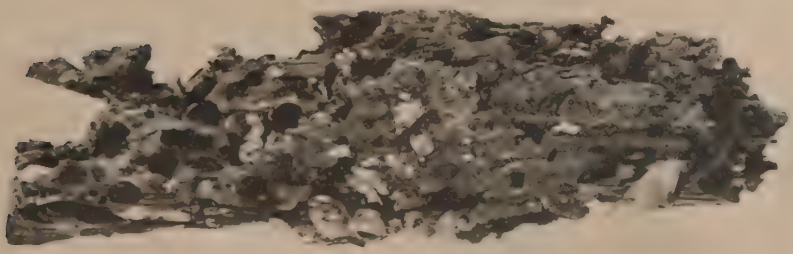

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PLATE 9

Fig. 6. *Teredo parksi* from Pearl Harbor, exterior of right valve. × 7.
Fig. 7. Same, interior of right valve.
Fig. 8. Same, outer face of pallet.
Fig. 9. Same, inner face of pallet.
Fig. 10. Shells of *Teredo parksi* from Cavite. × 5.
Fig. 11. Pallets of *Teredo parksi* from Cavite. × 5.
Fig. 12. Shells of *Teredo parksi* from Honolulu Harbor. × 5.
Fig. 13. Pallets of *Teredo parksi* from Honolulu Harbor. × 5.
Fig. 14. Shells of *Teredo parksi* from Tutuila. × 5.
Fig. 15. Pallets of *Teredo parksi* from Tutuila. × 5.

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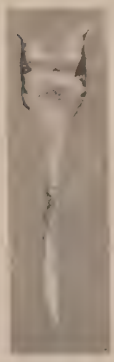

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PLATE 10

Fig. 16. *Teredo furcillatus* form Tutuila, exterior of right valve of the type. × 10.

Fig. 17. Same, interior of right valve.

Fig. 18. Same, outer face of pallet.

Fig. 19. Same, inner face of pallet.

Fig. 20. Series of pallets of *Teredo furcillatus* from Tutuila, selected to show variations. × 7.

Fig. 21. *Teredo samoaensis* from Tutuila, exterior of right valve of the type. × 10.

Fig. 22. Same, interior of right valve.

Fig. 23. Same, outer face of pallet.

Fig. 24. Same, inner face of pallet.

Fig. 25. Series of pallets of *Teredo samoaensis* from Tutuila, selected to show variations. × 7.

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PLATE 11

Fig. 26. *Teredo affinis* from Nawiliwili, exterior of right valve. × 10.

Fig. 27. Same, interior of right valve.

Fig. 28. Same, outer face of pallet.

Fig. 29. Same, inner face of pallet.

Fig. 30. Series of pallets of *Teredo affinis* from Nawiliwili, selected to show variations. × 10.

Fig. 31. *Teredo trulliformis* from Honolulu Harbor, exterior of right valve of type. × 10.

Fig. 32. Same, interior of right valve.

Fig. 33. Same, outer face of pallet.

Fig. 34. Same, inner face of pallet.

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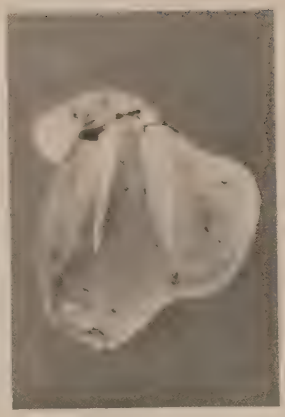

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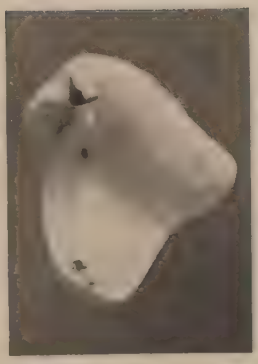

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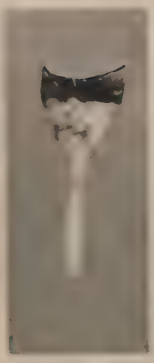

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The crustacean borers are represented in the test blocks from the islands by one species of the amphipod genus *Chelura*, and two species of the isopod genus *Limnoria*. Heavy attack by one or more of these species has occurred in the blocks from all stations mentioned in the preceding paper, with the exception of Nawiliwili, Territory of Hawaii, where the attack has been light, and Cavite, Philippine Islands, where no crustacean borers have been found.

Genus **Chelura**

Chelura insulae Calman

This species was described by Calman (1910) from Christmas Island in the Indian Ocean. It may readily be distinguished from the better known *Chelura terebrans* of Atlantic waters by the longer antennae and antennules, the enormously developed anterior gnathopods, and absence of the prominent spine on the third pleon segment which characterizes *C. terebrans*. In *C. insulae* the hind margin of the third pleon segment carries three short tubercles. The brush of hairs on the third uropods of the male is a further peculiarity of this species.

Chelura insulae occurs in great numbers in the blocks from Samoa, following up *Limnoria* and enlarging the burrows of the latter for its own occupancy. The organism apparently bores for food as well as shelter, as the passages it makes (pl. 13, fig. 8) are considerably larger than would be required for the latter purpose alone.

This species also occurs, though less numerously, in the blocks from Honolulu Harbor.

Genus **Limnoria**

Limnoria lignorum Rathke

This cosmopolitan pest occurs in considerable numbers in Pearl Harbor and, with *Limnoria andrewsi,* in Honolulu Harbor. A light and scattered attack by *L. lignorum* has occurred in the blocks from Nawiliwili.

The specimens from Hawaii are smaller than is usual for this species in our colder waters, averaging somewhat under 2.5 mm. in length. The length usually given for *L. lignorum* is 3 mm.; in San Francisco Bay the average length of adults of this species is 3.5 mm.

Limnoria andrewsi Calman

This species, like *Chelura insulae,* was described from Christmas Island by Calman (1910). It may be distinguished from *Limnoria lignorum,* as from the five other known species of *Limnoria,* by the relative shortness of the peduncle of the uropods; this in *L. andrewsi* is equal in length to or shorter than the outer ramus or exopod of the uropod, while in all of the other species the peduncle exceeds the exopod in length.

This species occurs in the blocks from Samoa in approximately the same numbers as *Chelura insulae.* The result of the combined action of the two is shown in plate 13, figure 6. *Limnoria andrewsi* also occurs with *L. lignorum* in Honolulu Harbor, where it greatly outnumbers the latter species, and at Nawiliwili, where both occur in limited numbers.

It is remarkable that, while *Limnoria andrewsi* is the dominant species in the test blocks from Honolulu Harbor, in the blocks from Pearl Harbor, only a few miles distant, *Limnoria lignorum* predominates to such an extent that if *L. andrewsi* occurs at all its presence has been overlooked.

The destruction of the test blocks by the crustacean borers has proceeded most rapidly in Honolulu Harbor (see pl. 13, fig. 7), where all three of the above-mentioned species occur together.

Zoological Laboratory,
University of California.

Transmitted March 20, 1924.

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EXPLANATION OF PLATES

PLATE 12

Fig. 1. *Chelura insulae*, male, from Tutuila, Samoa. × 17.

Fig. 2. *Chelura insulae*, female, from Tutuila. × 17.

Figs. 3, 4, and 5. *Limnoria andrewsi* from Tutuila. Dorsal, lateral, and ventral views of female carrying advanced embryos in brood pouch. × 17.

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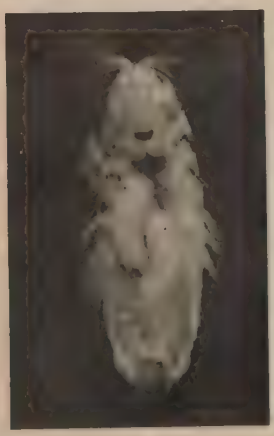

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PLATE 13

Fig. 6. Portion of a 3½ in. by 3½ in. by 6 in. test block submerged eight months at Tutuila, showing damage by *Limnoria andrewsi* and *Chelura insulae*. The ends of a few *Teredo* burrows have been exposed. × ¾.

Fig. 7. All that remained of a 2 in. by 3½ in. by 5 in. test block submerged eight months in Honolulu Harbor. The major damage was occasioned by *Limnoria andrewsi; Limnoria lignorum* and *Chelura insulae* were also present in the block. All *Teredo* were dead as a result of exposure of their burrows by the crustacean borers. × ¾.

Fig. 8. Portion of block from Tutuila, showing *Chelura insulae* in place in burrows. One *Limnoria andrewsi* is seen in place near lower left corner. × 5.

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